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prepared by Mr. David White accompanies the paper, showing the geological horizon as determined by paleo-botany and stratigraphy of the insect-bearing localities of the American Carboniferous.

"Die Fossilen Insekten," the second title of this year by Handlirsch, is intended to serve as "Ein Handbuch für Paleontologen und Zoologen." The fossil insects are treated chronologically by periods. No insects are recognized from deposits older than the Upper Carboniferous. The introductory part of the publication contains a synopsis of the orders of recent insecta. The Carboniferous insects are described in parts I, II, and III to p. 343. Permian insects follow (pp. 344 to 393). Mesozoic insects occupy the remainder of part III and IV. The remaining parts to be issued will complete the treatment of Mesozoic and Cenozoic forms in order. All known fossil Hexopoda are to be included in this work, and the described specimens so far as possible illustrated.

Sellard's paper on Odonata is Part I of a paper discussing the leading types of Permian insects. A new genus of Odonates, the first of this group obtained from the Permian, is described. The conclusions reached from a study of the Permian Odonates, and from a comparison of these with the Coal Measure forms, are that the wing venation of Paleozoic dragon-flies is not fundamentally different from that of modern dragon flies, as believed by Scudder, and that the Paleozoic dragon-flies are not to be separated as an order from Mezozoic and modern dragon-flies, as is done by Handlirsch, Three suborders are recognized for the order Odonata; Protodonata. Zygoptera, and Anisoptera. The second paper by Sellards is a résumé of the geological history of the cockroaches. Von Schlechtendal regards the vein in the hind wing of certain Coal Measure cockroaches, interpreted by Sellards as the costa, as being in reality the subcosta. Woodworth's paper on the wing veins of insects contains critical remarks on the venation of the wings of the better-known families of Paleozoic insects.

E. H. SELLARDS

The Place of Origin of the Moon—The Volcanic Problem. By WILLIAM H. PICKERING. *Journal of Geology,* Vol. XV, January–February, 1907, pp. 22–38.

To many geologists the arguments of this paper will appear to need no refutation and, if published in any other than a leading geological periodical, would not call for comment. There is danger, however, that by not formally presenting the contrary side of an argument, a greater credit and authority may be given to certain views by those in other branches of science than is warranted. It is because this article is of a nature which may lead to its being widely quoted by those not pretending to pass independent judgment upon the problem, that the following reply is written.

In 1879 Professor George H. Darwin gave cogent reasons for thinking that originally the moon was much nearer to the earth than it is at present, and considered it probable that the earth and moon at one time constituted a single mass, though this conclusion was admittedly in the nature of an inference from the preceding. As Professor Pickering states, this conclusion has been accepted by the great majority of astronomers, although many of the geologists do not view it with favor. Accepting this hypothesis as to the origin of the moon, the author states:

> When the Earth-Moon planet condensed from the original nebula, its denser materials collected at the lower levels, while the lighter ones were distributed with considerable uniformity over its surface. At the present day, we find the lighter materials missing from one hemisphere. The mean surface density of the continents is about 2.7. Their mean density is certainly greater. We find a large mass of material now up in the sky, which it is generally believed by astronomers formerly formed part of our Earth, and the density of this material, after some compression by its own gravity, we find to be 3.4, or not far from that of the missing continents. From this we conclude that this mass of material formerly covered that part of the Earth where the continents are lacking, and which is now occupied by the Pacific Ocean. In fact, there is no other place from which it could have come.
>
> Who it was that first suggested that the Moon originated in the Pacific is unknown. The idea seems to be a very old one. The object of the present paper is to find what support for this hypothesis is afforded by the results of modern science, when examined both qualitatively and quantitatively. (P. 30.)

All will agree that the hypothesis is a very interesting one and worthy of the space given to it, and, even if opposed by very strong objections, is still of value as a hypothesis in the absence of positive knowledge as to the age and ultimate origin of the ocean basins. It must be concluded, however, as shown in these two paragraphs as well as many others in the article, that the author has not only failed to look up and to give credit to the originator of the hypothesis, which is here duplicated in many details, but has treated many phases of the subject with a positiveness and superficiality which cannot commend themselves to careful students of the subject. This is in marked contrast to the cautious treatment of the hypothesis by its originator, Osmund Fisher, in his initial statement of it entitled, "On the Physical Cause of the Ocean Basins," *Nature*, Vol. XXV (1882), p. 243, or in his reprint of it as A Speculation on the Origin of Ocean Basins, chap. xxv, *Physics of the Earth's Crust*, pp. 336–41, 379–81 (second edition, 1889).

The hypothesis appeals to the imagination, and at first thought appears to offer a striking explanation of both the shape and depth of the ocean basins. There are, however, certain assumptions involved in this restatement of it which are not clearly indicated as such, and the difficulties are dismissed without serious treatment. It is to call attention to these, as well as to give credit to the original papers on the subject, that this review and criticism is written.

First, no discussion is given of the possibility that the interior density of the earth may be largely due to the gravitational compression of ordinary rock material, since Professor Pickering states:

> The specific gravity of the Earth as a whole is 5.6. That of the surface material ranges in general between 2.2 and 3.2, with an average of 2.7. The specific gravity of the Moon is 3.4. This indicates clearly that the Moon is composed of material scraped off from the outer surface of the Earth, rather than of matter obtained from a considerable depth. At the same time, the specific gravity 3.4 indicates that the layer of material removed had an appreciable thickness. (P. 24.)

Nothing is really known as to the limits of the compressibility of rock under pressures of millions of pounds per square inch, allowing the alternative hypothesis to be equally assumed, that the earth may be largely made up of material which would not have a specific gravity of much, if any, over 3, if free from subcrustal pressures. Following this assumption, the moon may have been abstracted from any part of that mass, and at any time before the present relation of heavier oceanic and lighter continental crustal segments originated. The continents may then have subsequently come into existence according to any one of a number of hypotheses, such as proposed by Chamberlin or others. As the moon's mass is but one eighty-first that of the earth, its radius but a fourth, and gravity at its surface but one-sixth, it is seen that the material of the moon would suffer comparatively little compression even in its deeper parts, while its outer parts may consist of highly cellular rocks.

Second, this hypothesis rests upon the doctrine of the perpetual existence of the present forms and relations of the continental platforms. This is passed over with the statement that "it is the general opinion among geologists that the continental forms have always existed—that they are indestructible" (p. 28).

From the early advocacy of J. D. Dana, this may be called an American view, and represented a wholesome return from previous untrammeled speculations regarding the interchangeability of ocean basins and continental platforms. That Dana himself, however, came to a belief in a liberal interpretation of this doctrine might have been easily determined by consulting the last edition of his manual (pp. 737, 1019), where it is seen that he accepts, as probable, former extensions of land in the Southern Hemisphere by which all of the now isolated land masses were connected. That a present belief in the strict permanence of the continental outlines is not shared by many geologists, especially by Europeans, is indicated by the paleogeographic maps in many books and articles, among which may be singled out the *Traité de Géologie* by A. de Lapparent (1911 pages; fourth edition, 1900).

Such maps are largely based upon paleontological evidence from many groups of animals and plants, and consequently appeal most strongly to the paleontologist, but that there is structural evidence for the view of former extensions of the continental platforms beyond their present limits may be gleaned from the monumental work of Suess, *Das Antlitz der Erde.*

In view of these statements, it may be said that it is the opinion of many well-qualified geologists that, while no large areas of oceanic basins have been uplifted and added to the continental platforms, there has been, on the contrary, an intermittent but progressive continental fragmentation through geological time by which land masses, most notably Antarctica, have been isolated and reduced in size, and the area of the oceanic basins correspondingly increased. The consequent enlargement of volume of those basins has tended to drain the shallow seas from the continental platforms and cause an intermittent but progressive emergence of the lands. Relative vertical movements of the oceanic segments and erosion of the lands have, however, also been major factors further complicating the result. The only known limitations to such changes of continental relations appear to be given by the general maintenance through geological time of the critical relations of the sea-level to the continental surfaces, and if, as seems probable, the volume of sea-water has increased through time, the area of the continental ptalforms may, in somewhat like measure, have decreased. These views affect the present hypothesis of the place of origin of the moon in two ways: by indicating that the Atlantic and Pacific may not always have possessed their present forms; but further, and more importantly, that the causes of the existence of ocean basins and continental platforms are not to be found alone in a primal cause no longer acting, but, to a considerable extent at least, to still acting and persistent causes.

Interesting consequences of certain suggestions put forth may be seen by comparing the last paragraphs on pages 32 and 33 respectively. The logical conclusion from these is that the ocean basins, formed by the breaking away of the moon, may not have existed until the end of the Paleozoic, with the result that, granting the present volume of sea-water, a universal ocean, averaging 10,400 feet deep, previously covered the whole earth. How, under such conditions, there came to be any sediments in the Appalachian geosyncline from a land "of continental proportions" the author does not attempt to explain.

Again, on page 31, the basic nature of the Hawaiian lavas is explained as a consequence of the removal of the lighter acid crust from the ocean basins to make the moon. It is easy to see how on this hypothesis the author would account for the enormous basaltic outpourings which have taken place over the surface of the continents, but it would be interesting to have his explanation of the fact that in Washington's tables of chemical analyses of igneous rocks the only analysis reported from Kerguelen Island gives a phonolite with 58.2 per cent. of silica and 12.0 of alkalies; the only one from Gough's Island a trachyte obsidian with 61.2 per cent. silica and 12.4 of alkalies; the only two from Ascension Island are trachyte and obsidian, the former with 71.0 per cent. of silica, the latter with 72.7.

The second part of the article, entitled "The Volcanic Problem," does not seem to have any very clear or close relation to the first part on the "Place of Origin of the Moon."

JOSEPH BARRELL

Essentials of Crystallography. By E. H. KRAUS. Ann Arbor, Mich.: Geo. Wahr. Pp. x+162; 427 figs. in text.

In the words of the preface, this book is "intended for beginners and aims to present the essential features of geometrical crystallography from a standpoint which combines the ideas of symmetry with those of holohedrism, hemihedrism, etc." All the possible crystal forms are discussed with the important classes pointed out.

A bibliography of forty-one titles of important reference books and articles is at the beginning of the book. This is followed by a sixteen-page general discussion of the properties of crystals, their arrangement into systems, the symbols used, the symmetry, and tractional forms. The systems are then taken up in order, beginning with the cubic and following through to the triclinic. The relations of axes, symmetry, and possible classes are taken up with considerable care in each system.

Compound crystals, with a full discussion of the laws of twinning, forms the last chapter, and is followed by a concise tabular classification of the classes, showing at a glance the planes, axes, and centers of symmetry, the possible forms, and the representatives, when known, of each class.